IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application Serial No.: 10/821,751	Group Art Unit: 2891
Filing Date: December 30, 2002	Examiner: Yevsikov, Victor V.
For: Surface Treatment Using Iodine Plasma To Improve Metal Deposition	Docket No: 101.114
	Confirmation No.: 1874
Inventors: Dalton et al.	Attachment to Response

DECLARATION OF SANJAY GOPINATH

I, Sanjay Gopinath, hereby declare:

1. I am a Team Leader at Novellus Systems, Inc., working at the Novellus facility located at 4000 North First Street, San Jose, CA 95134, where I am involved in conducting various research and development activities, which include developing metallization processes and structures for integrated circuit fabrication. All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true.

2. My formal education includes a Master of Engineering from Cornell University. I have worked for 9 years as a Process engineer, Sr Process Engineer, and Team Leader. I have authored 4 published papers on the subject of integrated circuit process engineering. I am a named inventor in 6 issued patents in the field of integrated circuits. A copy of my curriculum vitae is attached hereto as Exhibit A.

3. I am one of the inventors and Novellus Systems, Inc. is the assignee of the above-designated patent application (hereinafter "the application").

4. I submit this Declaration to present to the Examiner, in an authenticated manner, facts concerning the relevance of references cited in the Office Action dated June 15, 2005 (hereinafter "the Office Action").

5. I have read the currently pending claims 1 – 41 of the application, the Office Action, and the references cited by the Examiner, in particular, Agarwal et al., U.S. Patent No. 6,365,486, issued April 2, 2002 (hereinafter "Agarwal et al"); Huang et al., U.S. Patent

No. 6,146,941, issued November 14, 2000 (hereinafter "Huang et al); Pyo et al., U.S. Patent No. 6,593,236, issued July 15, 2003 (hereinafter "Pyo et al."); Vaarstra et al., U.S. Patent No. 6, 074, 945, issued June 13, 2000 (hereinafter "Vaarstra et al."); and Lane et al., U.S. Patent No. 6, 812, 143, issued November 2, 2004 (hereinafter "Lane et al.").

6. The present invention does not teach formation of a layer having a finite thickness during plasma treatment.

7. Formation of a passivation layer having a finite thickness by converting the underlying substrate to a diffusion barrier as in Agarwal et al. would render the present invention useless because it would unacceptably alter the dielectric constant and other electronic properties of substrate layers surrounding metallization layers.

8. If the teaching of Agarwal et al. were modified to make a plasma-treated substrate as in the present invention, then the resulting plasma-treated substrate would not be useful as a protective passivation layer as in Agarwal et al. This is because a plasma-treated surface in accordance with the present invention does not provide a protective passivation layer between a starting substrate (e.g., the dielectric of Agarwal et al.) and the ruthenium thin-film deposited on the substrate.

9. A principle of operation of the passivation layer of Agarwal et al. is formation of a passivation layer having a finite thickness that serves to prevent diffusion, chemical interaction and any physical contact between a dielectric layer and an adjacent metal electrode layer.

10. The principle of operation of the present invention is plasma treatment of a dielectric layer (or other substrate layer) to promote in a desirable way the physical contact and chemical interaction between the dielectric layer (or other substrate) and the metal (i.e., ruthenium) deposited on it.

11. Thus, the principle of operation of Agarwal et al. is no contact and no interaction, whereas the principle of operation of the present invention is enhanced physical contact and a desired interaction and reaction (i.e., enhanced nucleation of ruthenium metal on the substrate and slowed deposition rate). These principles of operation are mutually exclusive, so that a method in accordance with the present invention is inconsistent with the principle of operation of Agarwal et al.

12. Agarwal et al. do not teach any of the operating conditions or any details regarding their use of plasma. As a result, one skilled in the art would have to conduct many experiments to find plasma conditions for enhancing a reactive gaseous environment in a method of Agarwal et al.

13. Agarwal et al. do not teach generating a plasma discharge to create excited iodine species from an iodine-containing precursor gas and exposing a dielectric layer or other substrate to excited iodine species. Instead, Agarwal et al. merely teach converting a dielectric layer to a passivation layer that may contain iodine. Pyo et al. teach formation of a chemical enhancer layer from an iodine-containing compound without mentioning use of plasma. Therefore, there is no suggestion in the references or in the art to combine Agarwal et al. with an iodine-containing compound of Pyo et al. to make excited iodine species with a plasma.

14. Pyo et al. teach formation of a chemical enhancer layer to speed up the MOCVD deposition rate of copper onto a copper seed layer. Thus, the purpose of the invention of Pyo et al. is completely unrelated to the purpose of Agarwal et al. Therefore, there is no suggestion in the references or in the art of an expectation of success or of the desirability of using an iodine-containing compound of Pyo et al. in a reactive atmosphere of Agarwal et al.

15. A method in accordance with the present invention treats a substrate with excited iodine species to improve deposition of a ruthenium thin film by decreasing the nucleation delay of ruthenium growth on a plasma-treated substrate and also by decreasing the deposition rate of ruthenium onto a plasma-treated substrate. In contrast, Pyo et al. teach that a chemical enhancer layer formed using an iodine-containing compound of Pyo et al. actually accelerates the deposition speed of copper. Pyo et al., col. 1, lines 41—42. Therefore, the use of an iodine-containing precursor in the present invention to plasma-treat a substrate, resulting in decreased deposition rate of ruthenium, was contrary to the accepted wisdom in the art of using an iodine compound to increase the speed of metal deposition.

16. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and

that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

9/14/05
Date

Sanjay Gopinath